Community Exposures to Particulate Matter Air Pollution from the World Trade Center Disaster

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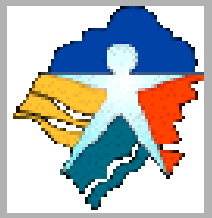
SCHOOL OF MEDICINE

NEW YORK UNIVERSITY



Acknowledgements

- George Thurston, Sc. D. Epidemiology, Source Apportionment
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NYU WTC Investigations have Focused on Particle Air Pollution

- Exposures to high levels of Particulate Matter (PM) air pollution, such as soot, can have severe health effects, including:
  - increased numbers of hospital admissions,
  - heart attacks;
  - asthma exacerbations.
- PM health effects are mostly among especially at-risk people, such as children and those with pre-existing health problems (e.g., emphysema or cardiac problems).

Continuing WTC Efforts at NYU funded by NIEHS

- Firefighters Studies (Rom)
  - CT Scan, Lavage
- WTC Resident Respiratory Impact Studies (Reibman)
  - Determine incidence/prevalence of new onset respiratory symptoms; exacerbation of previously diagnosed asthma;
- Particle Characterization and Exposure Assessment
- *In Vitro* and *In Vivo* Experiments (EPA/Rochester)
  - Inflammatory markers; effect in compromised animals
- Community Outreach and Education (e.g., Newsletter and October 17, 2002 WTC Research Forum at BMCC)

WTC dusts did not elicit remarkable toxicological effects

- EPA NHEERL (Gavett, Costa)
  - Mild to moderate pulmonary inflammation at high dose
  - Highly significant degree of sensitivity to airway constricting drug Mch (airway hyperresponsiveness) at high dose.
- U Rochester (Oberdorster, Finkelstein, Elder)
  - No delayed increase in response to WTC dusts
  - No effects were unmasked when combined with exposures to influenza virus
  - Exposure to dusts collected near the site of collapse of the WTC towers does cause more inflammation than exposure to a nuisance dust (TiO_2)

However, many residents developed persistent respiratory symptoms

- Increased rate of respiratory sx and medical care in "previously normal" residents living near Ground Zero compared to a control population.
- Respiratory symptoms were more persistent in a cohort of "previously normal" residents living near Ground Zero compared to those in a control area.
- Previously "normal" subjects with "new onset, persistent symptoms" frequently demonstrated BHR.

Data: Reibman et al 2004.

New-onset respiratory symptoms in "previously normal" residents[a]

	Exposed (n=2103)	Control (n=254)	Crude RR (95% CI)*
Cough without cold, %	40.6	12.1	3.36 (2.38-4.74)*
Night-time cough, %	36.7	11.7	3.15 (2.21-4.48)*
Wheeze, %	28.4	6.6	4.32 (2.68-6.98)*
Daytime SOB,%	27.2	10.4	2.62 (1.80-3.83)*
AM chest tightness,%	23.7	7.9	3.00 (1.93-4.65)*
SOB after exercise,%	18.1	4.7	3.86 (2.15-6.94)*
Night-time SOB,%	15.8	4.5	3.48 (1.94-6.25)*
Any of the above symptoms,%	**55.8**	**20.1**	**2.78 (2.17-3.56)***

[a]No diagnosis of asthma, chronic obstructive pulmonary disease, chronic bronchitis, or other lung disease before 9/11/2001.

•Effect still statistically significant after adjusting for age, gender, education, smoking and race.

Data: Reibman et al 2004.

"Persistent[b] new-onset respiratory symptoms" in "previously normal" residents

	Exposed (n=2410)	Control (n=271)	Crude RR (95% CI)*
Cough without cold,%	16.0	4.0	3.99 (2.15-7.38)*
Night-time cough, %	12.9	3.7	3.51 (1.83-6.72)*
Daytime SOB, %	10.6	3.6	2.94 (1.53-5.66)*
Wheeze, %	10.5	1.6	6.50 (2.44-17.33)*
AM chest tightness, %	8.4	1.6	5.21 (1.95-13.91)*
SOB after exercise, %	7.4	1.7	4.45 (1.66-11.91)*
Night-time SOB, %	6.2	0.8	7.64 (1.90-30.70)*
Any of the above symptoms, %	**26.4**	**7.5**	**3.53 (2.28-5.47)***

[b]Symptom frequency ≥ 2 days per week in the past 4 weeks.
* Effect still statistically significant after adjusting for age, gender, education, smoking and race.

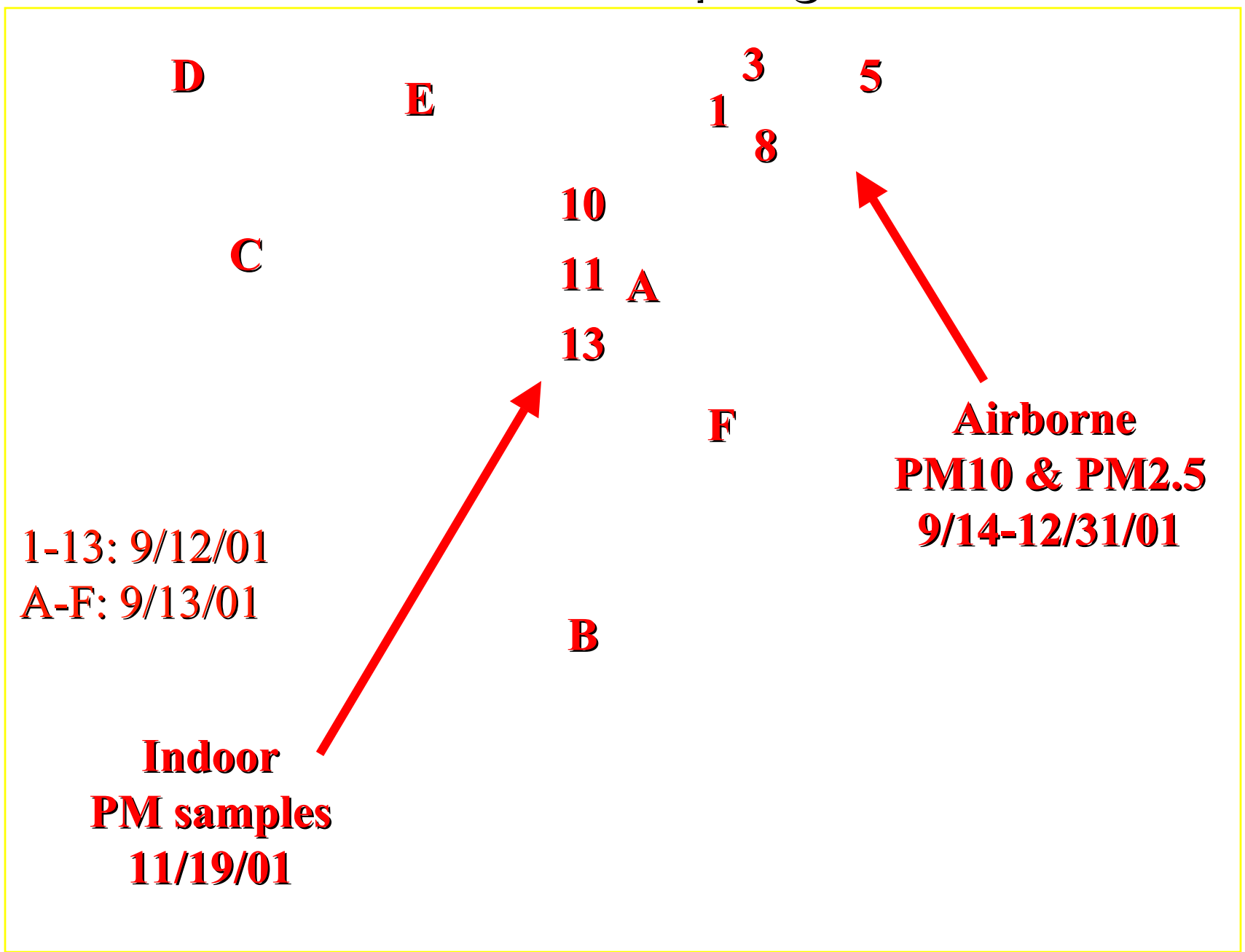
Data: Reibman et al 2004.

What Particle Samples Have We Collected?

- DUST "FALLOUT" SAMPLES
  - WTC Ground Dust Samples collected on 9/12-13/01
  - Apartment buildings in November, 2001
- AMBIENT AIR POLLUTION SAMPLES
  - Lower Manhattan: NYU Downtown Hospital (>9/14)
  - Midtown: Hunter College, 26th St. and 1st Ave.:
  - Background: Sterling Forest (40 miles NW of NYC)

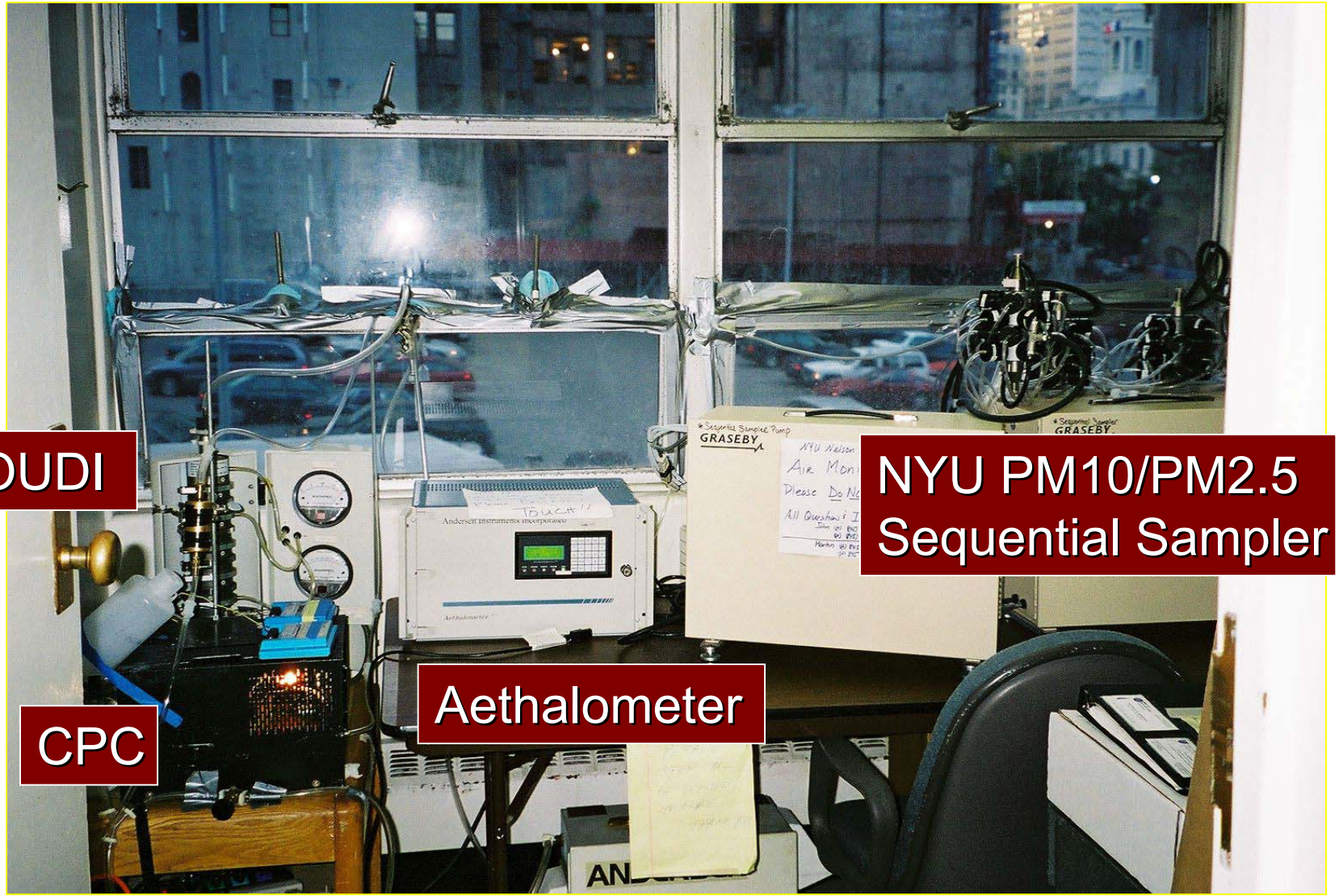
WTC Dust Samples Were Collected by Our Team on 9/12 and 9/13/01

NYU WTC Sampling Sites



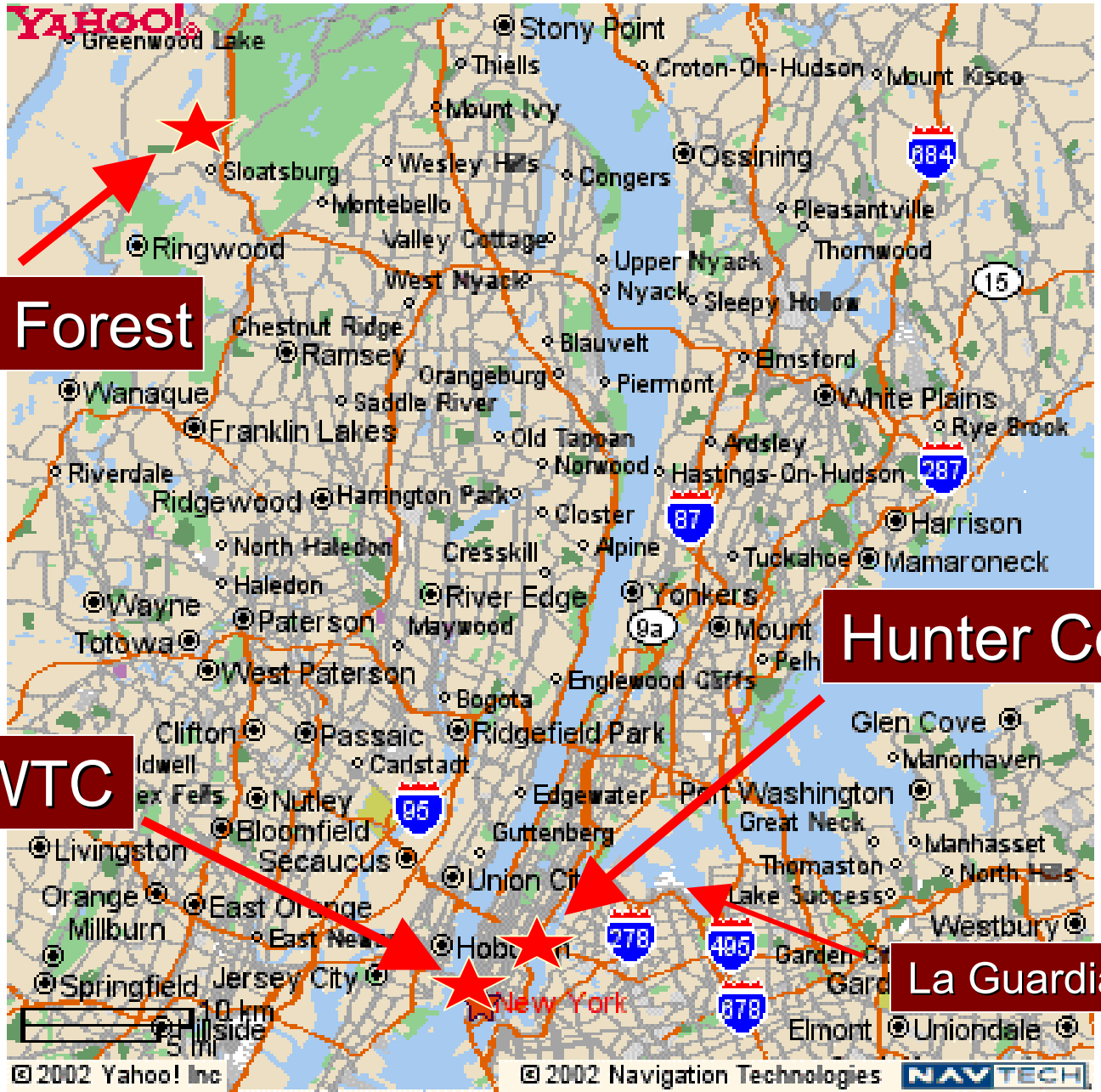
Particle Air Data Collected at NYU Downtown Hospital (9/14 - 12/31/01)

Multiple Sampling Systems Temporarily Installed at NYU Downtown Hospital




ELLIS PETERS
Barbie
The Spice and Spirit of Kosher Jewish Co
Julia Child & Company
The Victory Garden Cookbook

Ambient PM Sampling Sites



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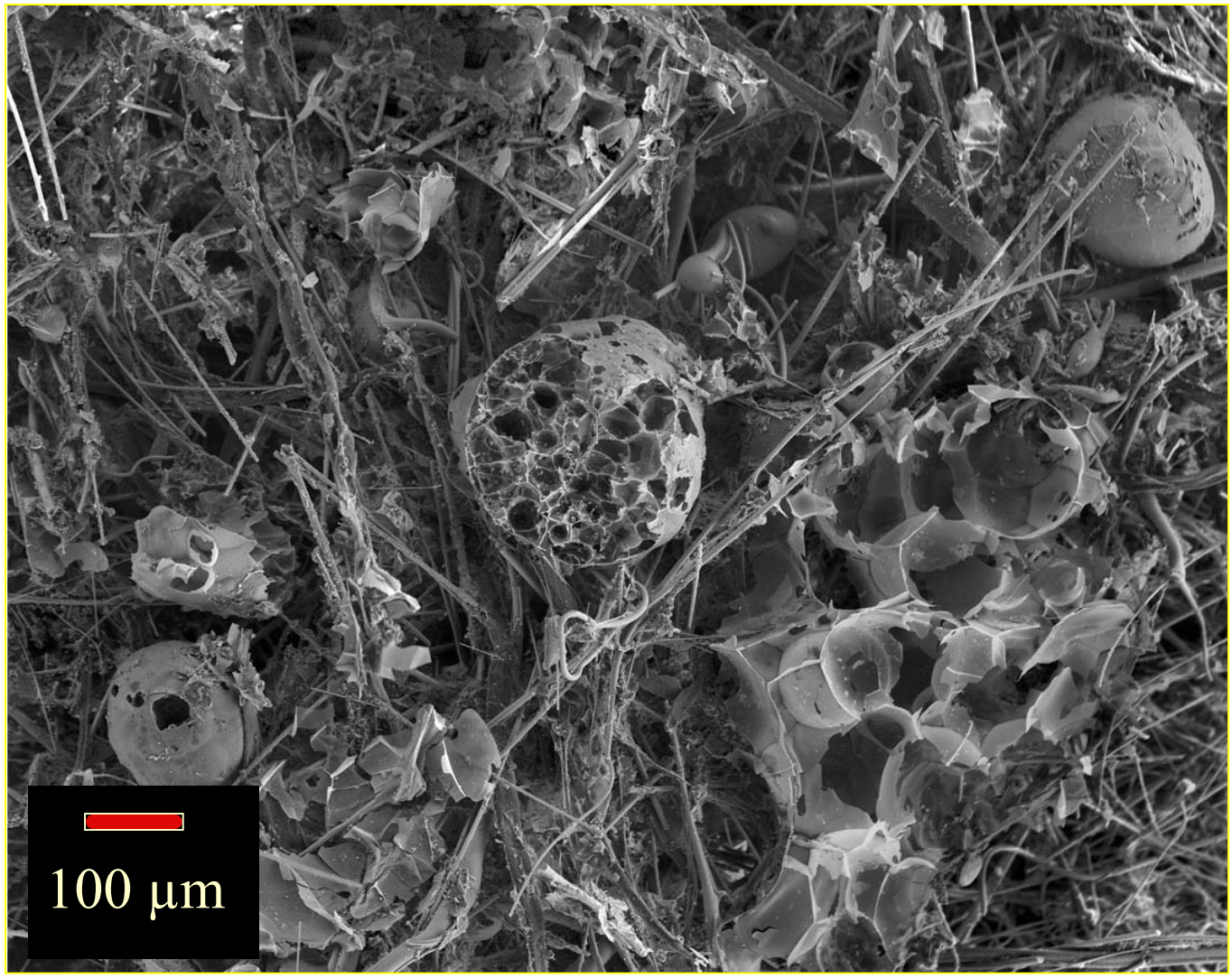
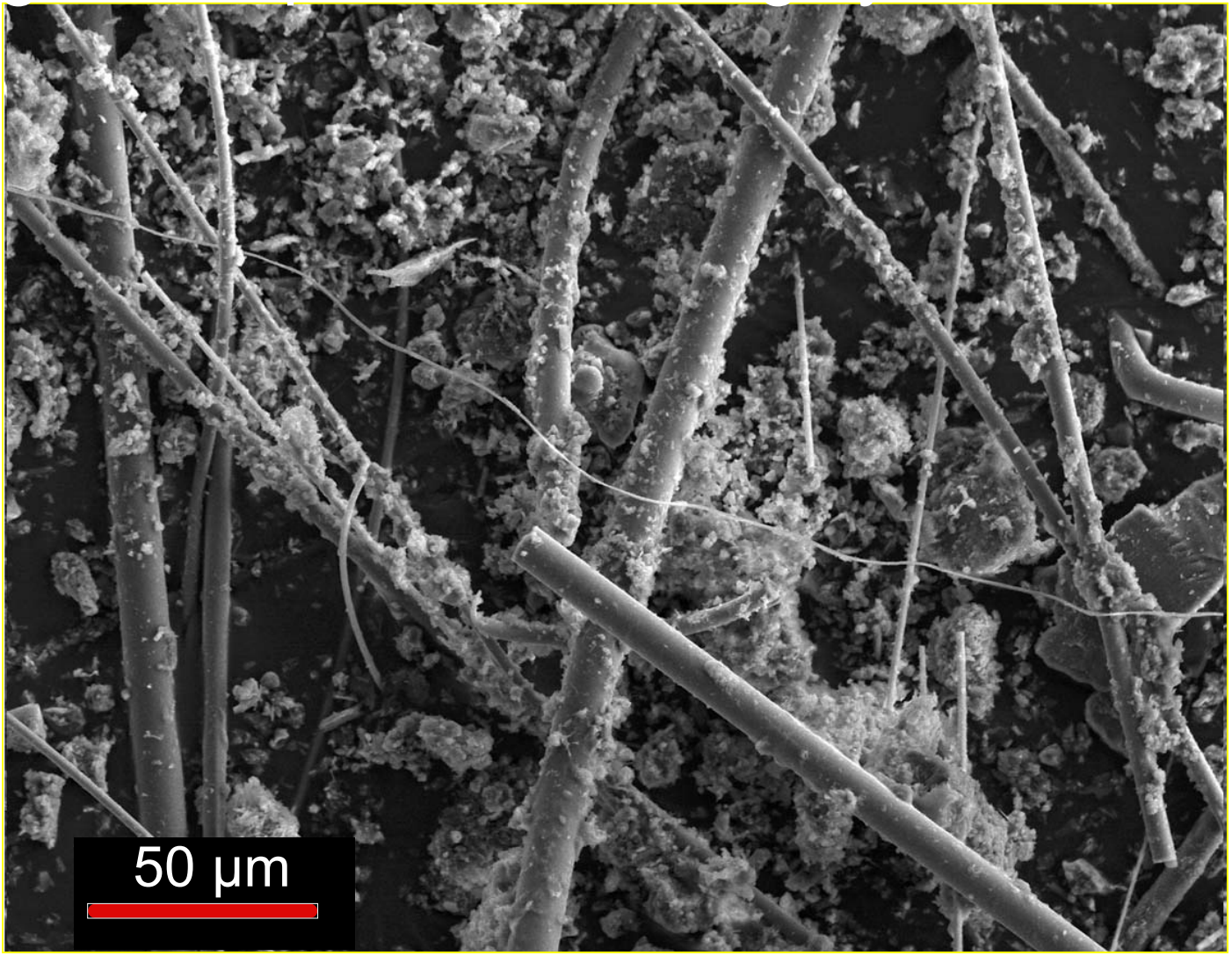


Photo by Dee Berger, LDEO, Columbia University



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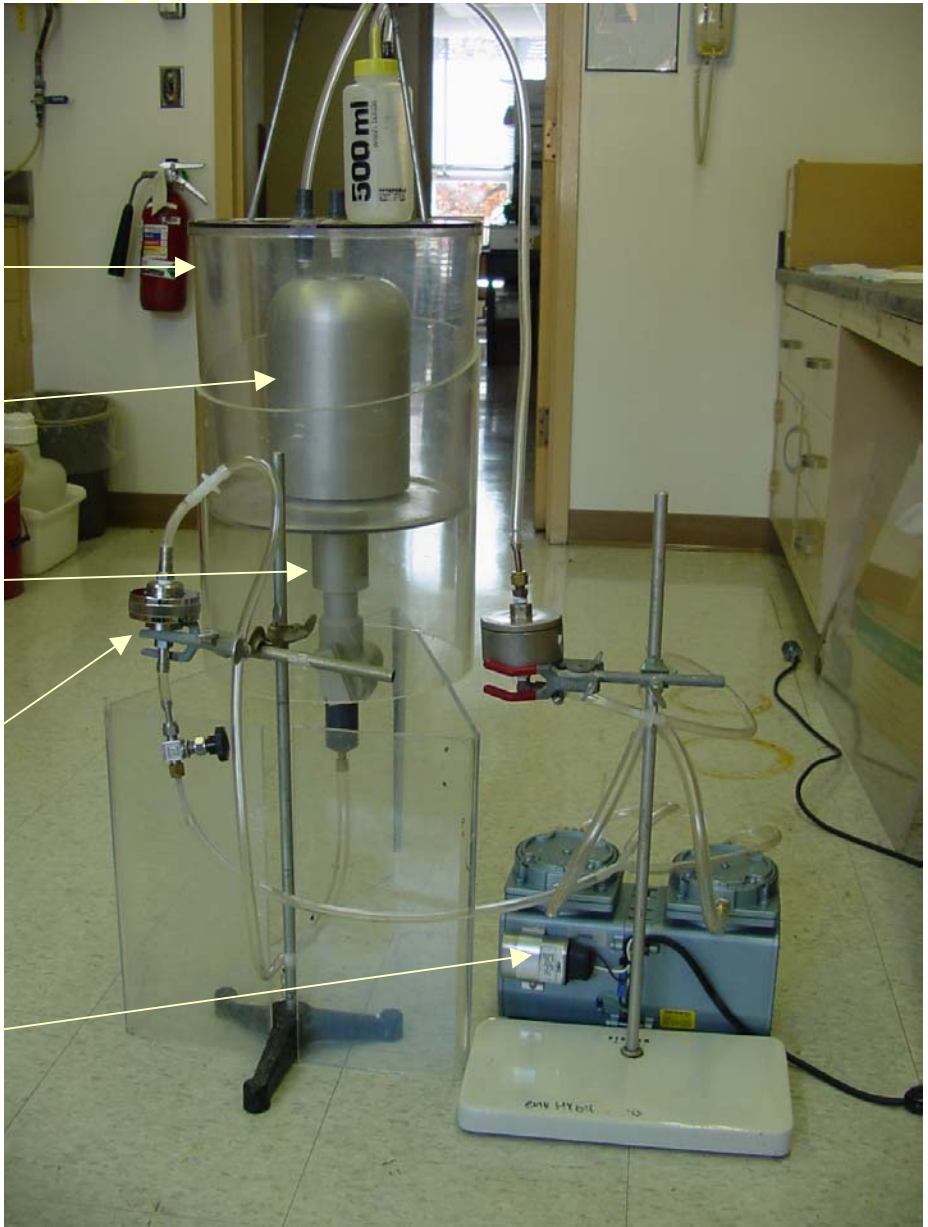
WTC dust was size separated using an air elutriation system



Resuspension Chamber

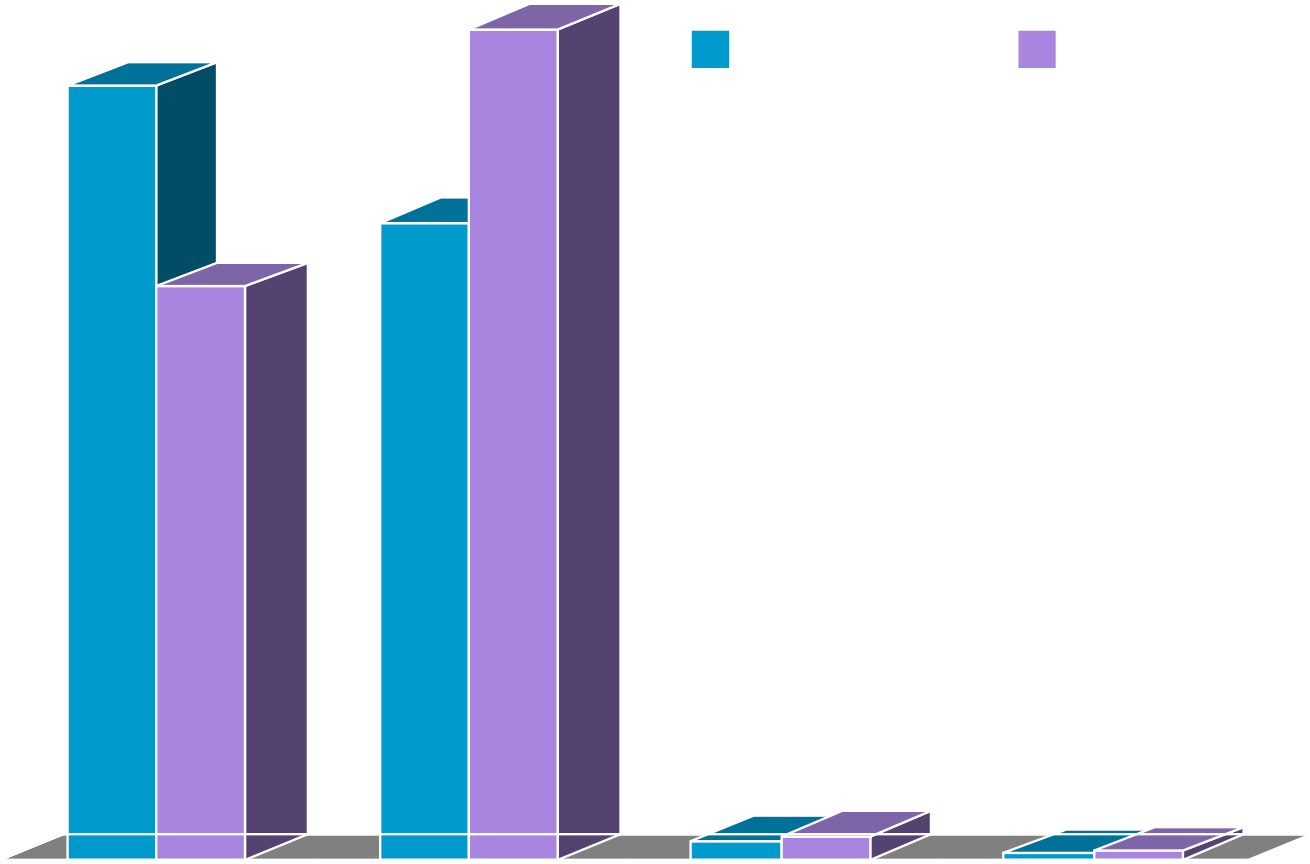
PM10 Inlet

PM2.5 Cyclone

Filter Holder

Pump

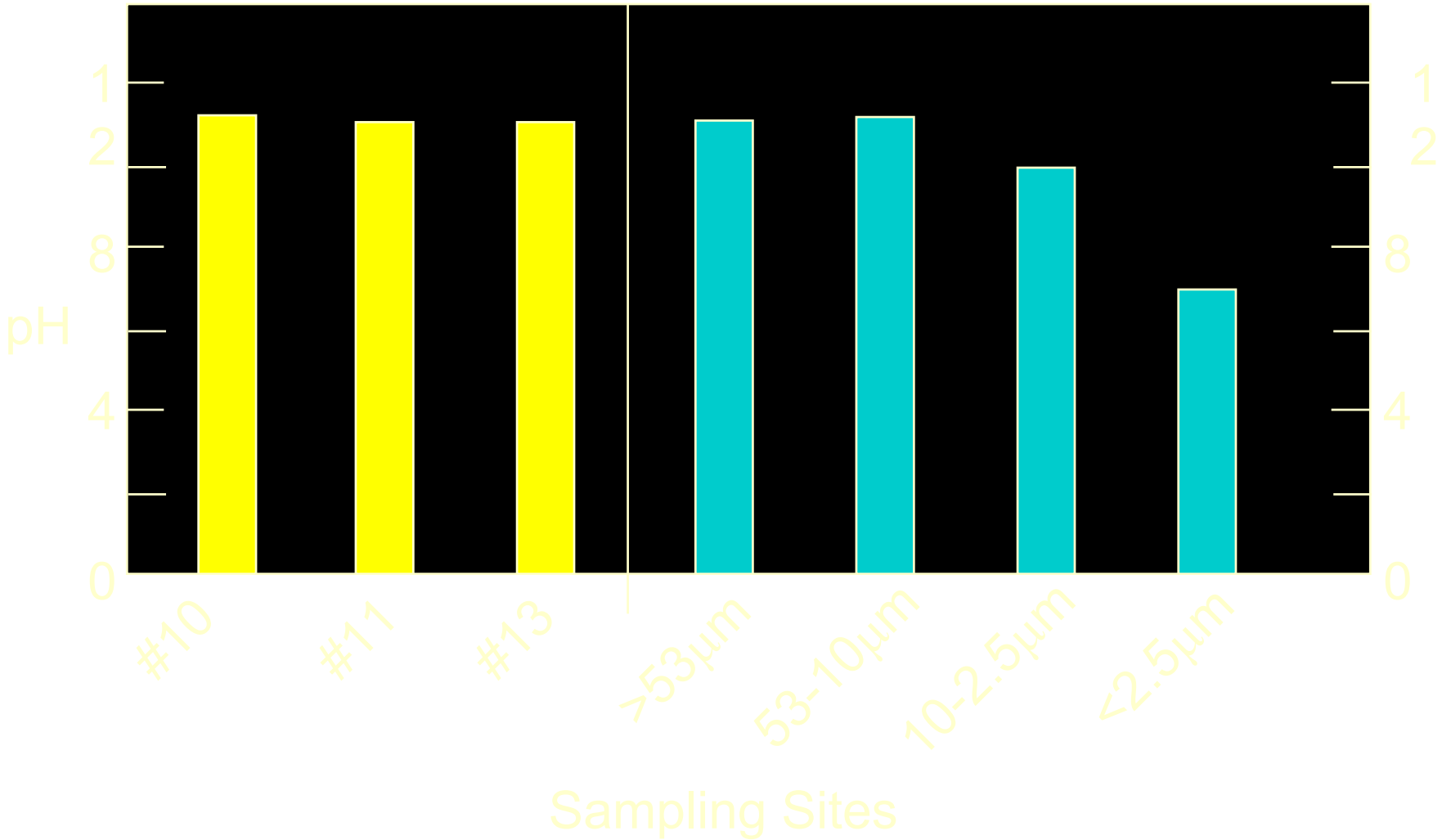
Most WTC Dust Particles are Larger than 10 µm, and Tend not to Penetrate Past the Throat into the Lung



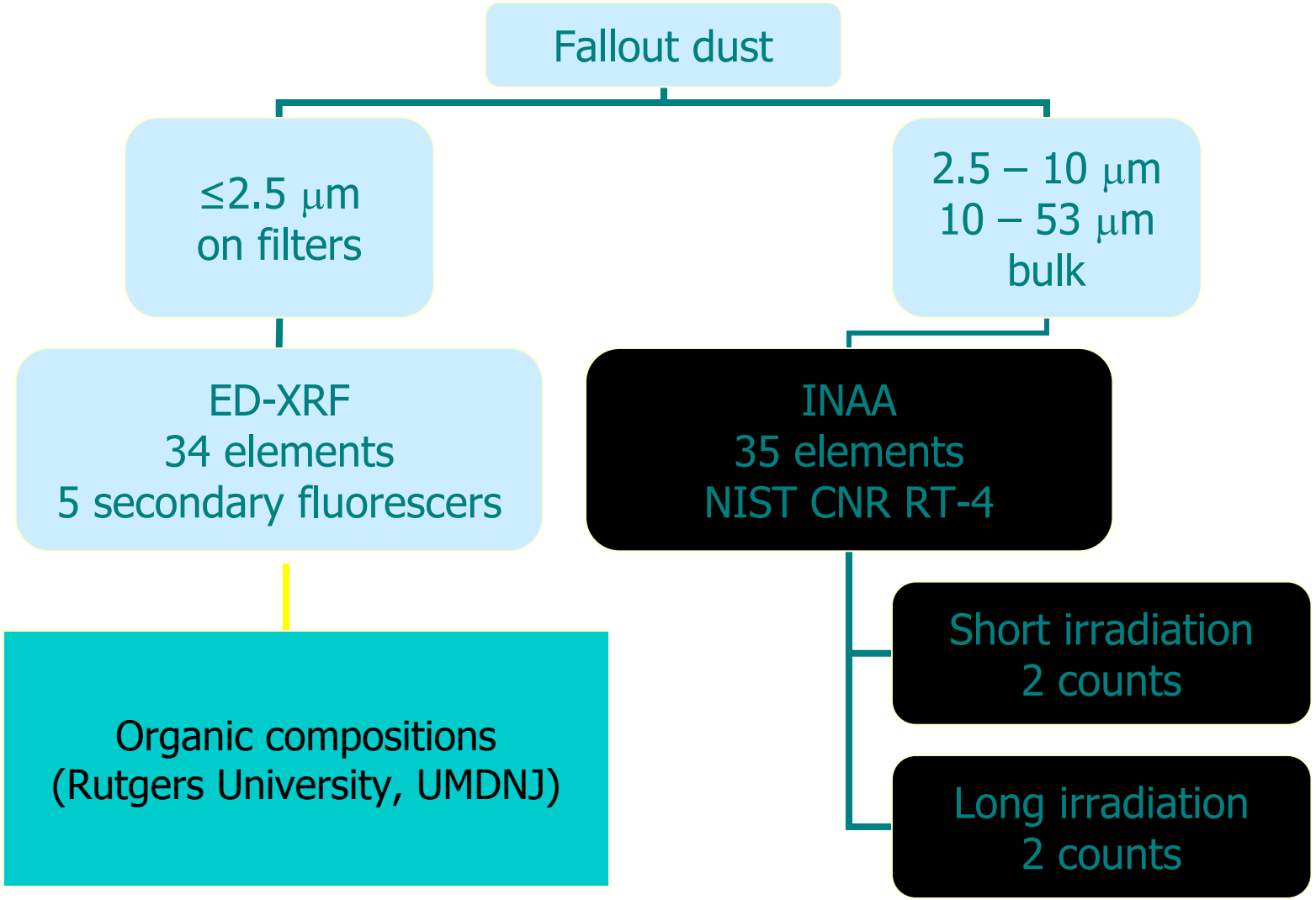
Very Low Levels of Asbestos found in the WTC Dust Samples

Sample	Chrysotile	Amosite	Cellulos	Mineral Wool	Non-Fibrous
10	0.3%	none	10%	40%	49.7%
11	0.3%	none	10%	40%	49.7%
13	0.3%	none	10%	40%	49 %
> 53 µm	none	none	0.5%	42%	57.5%
53 – 10 µm	trace	trace	5%	40%	55%
< 2.5 µm	none	none	5%	none	95%
Park 3	0.8%	none	10%	40%	49%
Cortland 3	0.8%	none	9.2%	40%	50%
145 Nassau (indoor)	none to 0.5%	none	13%	30%	57%

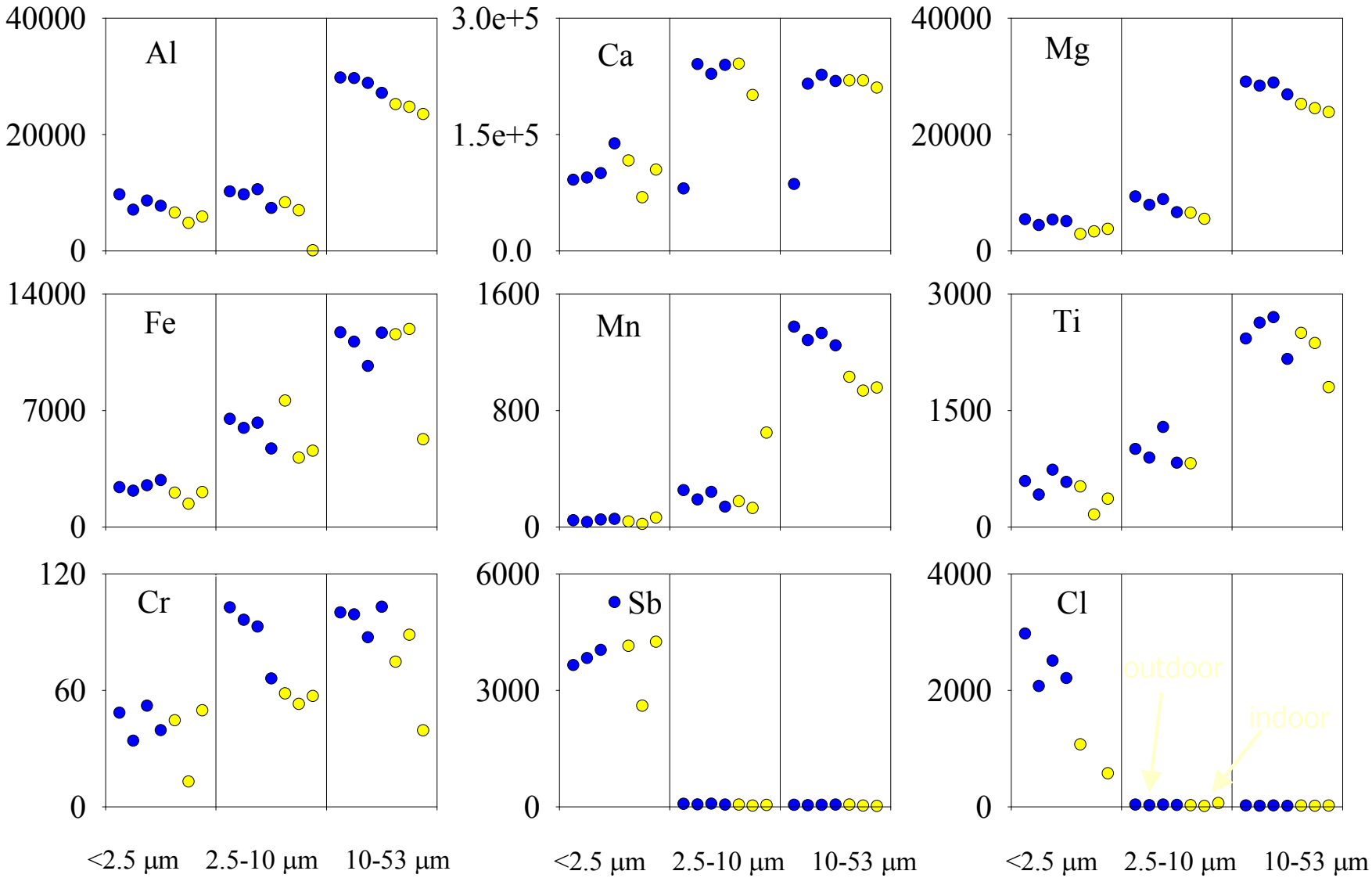
Large Dust Particles Were Alkaline and Irritating, But Small Particles (that can get into the Lung) Were Not



Chemical composition analyses of dust by 3 methods



Size Distribution of WTC Dust elements (in ppm) Indicate Different Particle Sources



Atmospheric Levels of Elemental Carbon (Soot) Lower Manhattan, 9/15 –10/15/2001

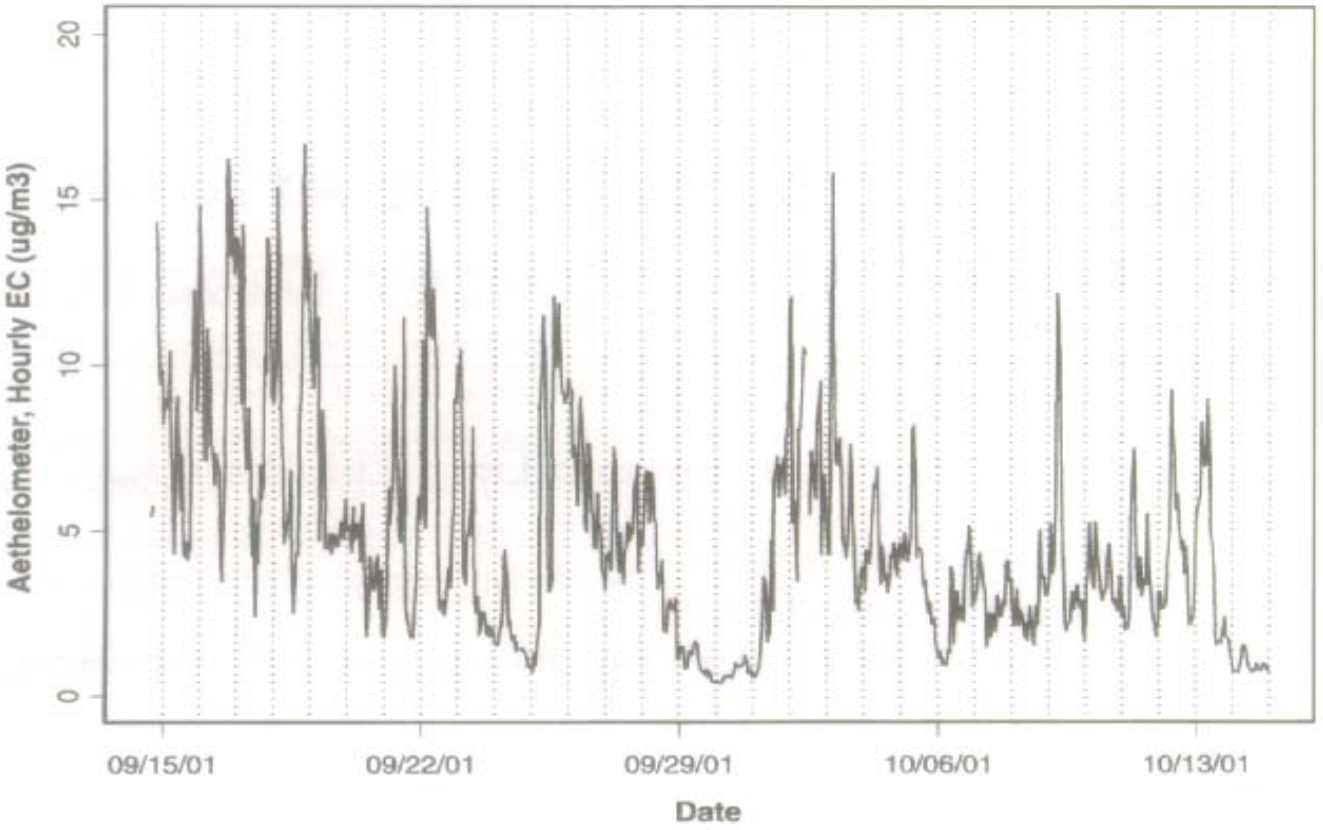
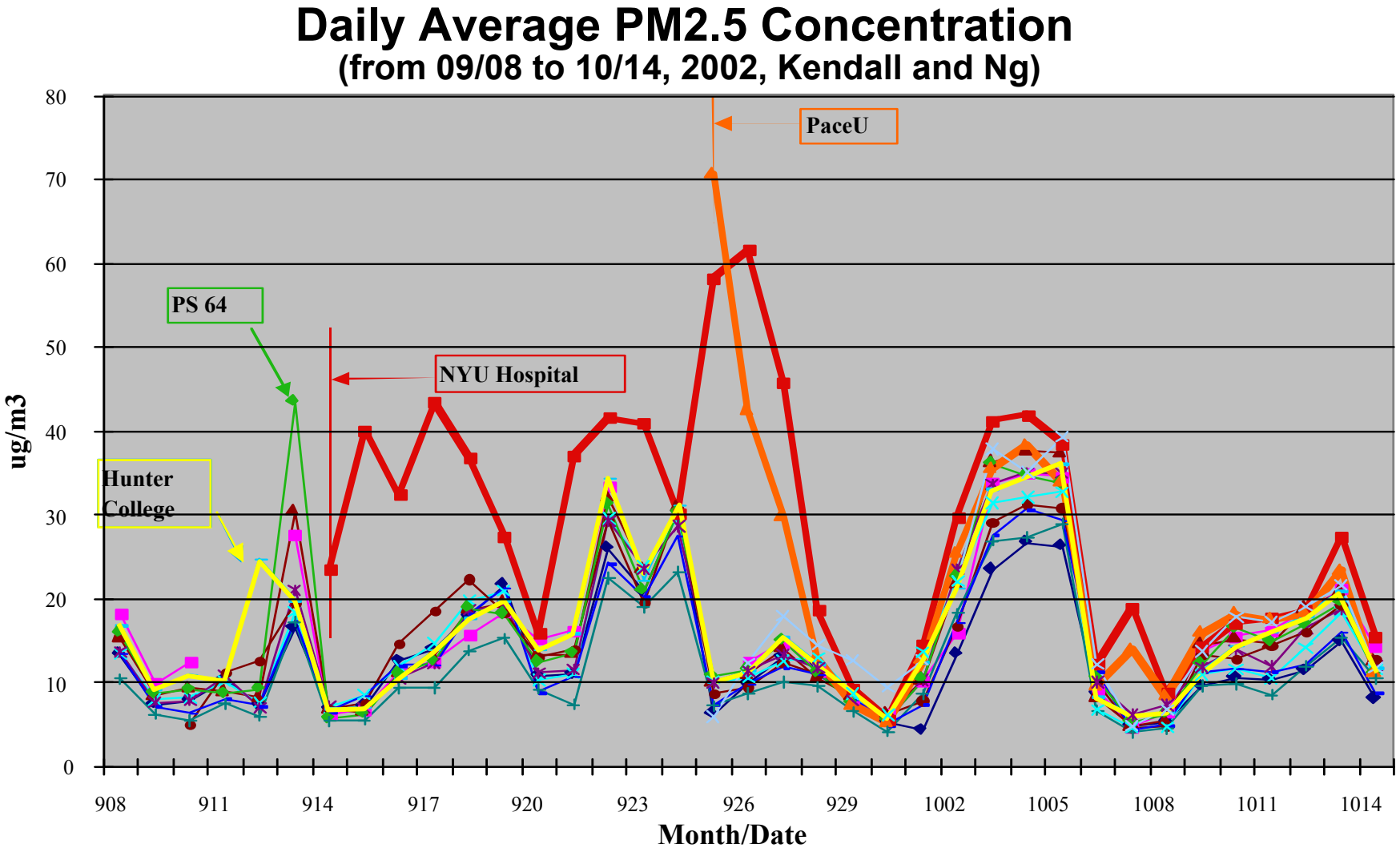


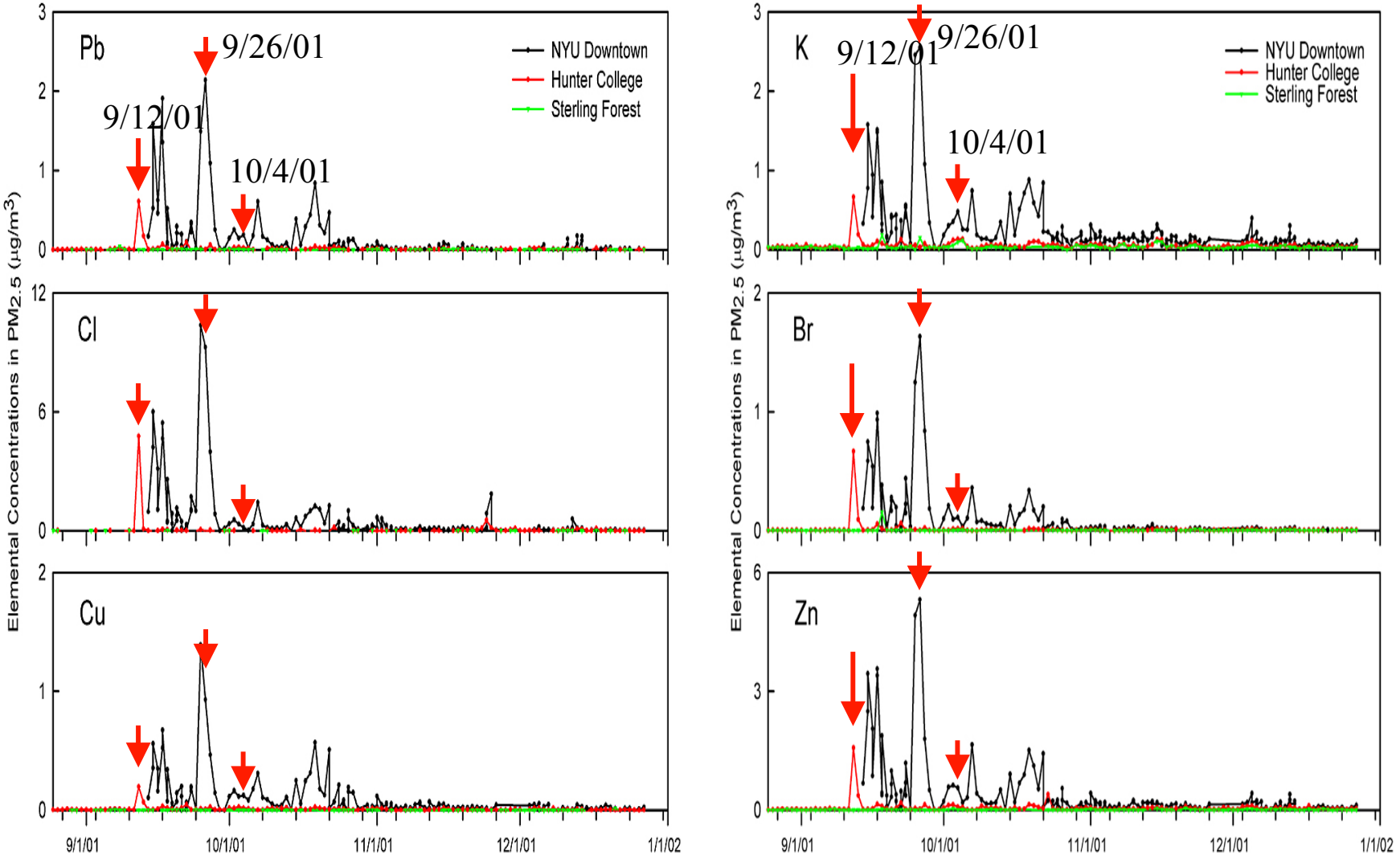
FIGURE 1. Elemental carbon (soot) levels (September 15-October 15, 2001) were elevated in lower Manhattan at night in the weeks following the disaster, but declined over time as the fires diminished.

Thurston and Chen

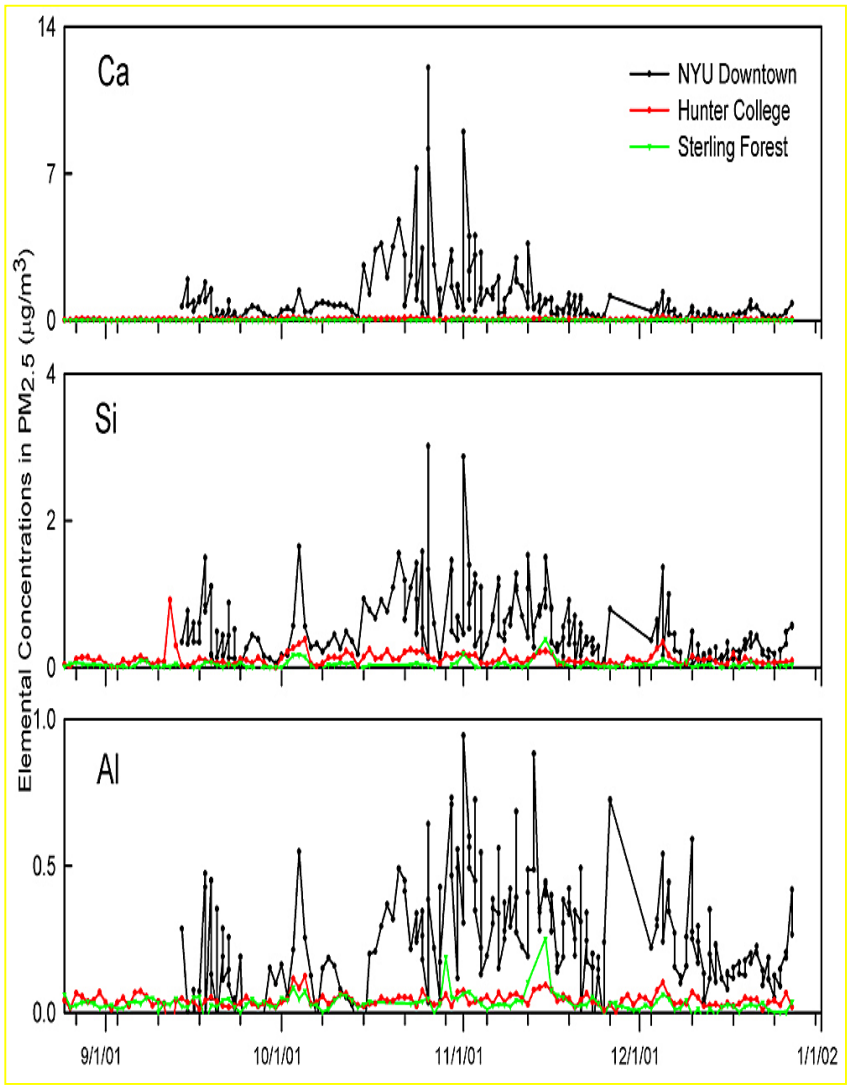
Fine Particle ($PM_{2.5}$) Levels in Lower Manhattan were Higher Than Elsewhere in September, but Became Like the Rest of the City In October



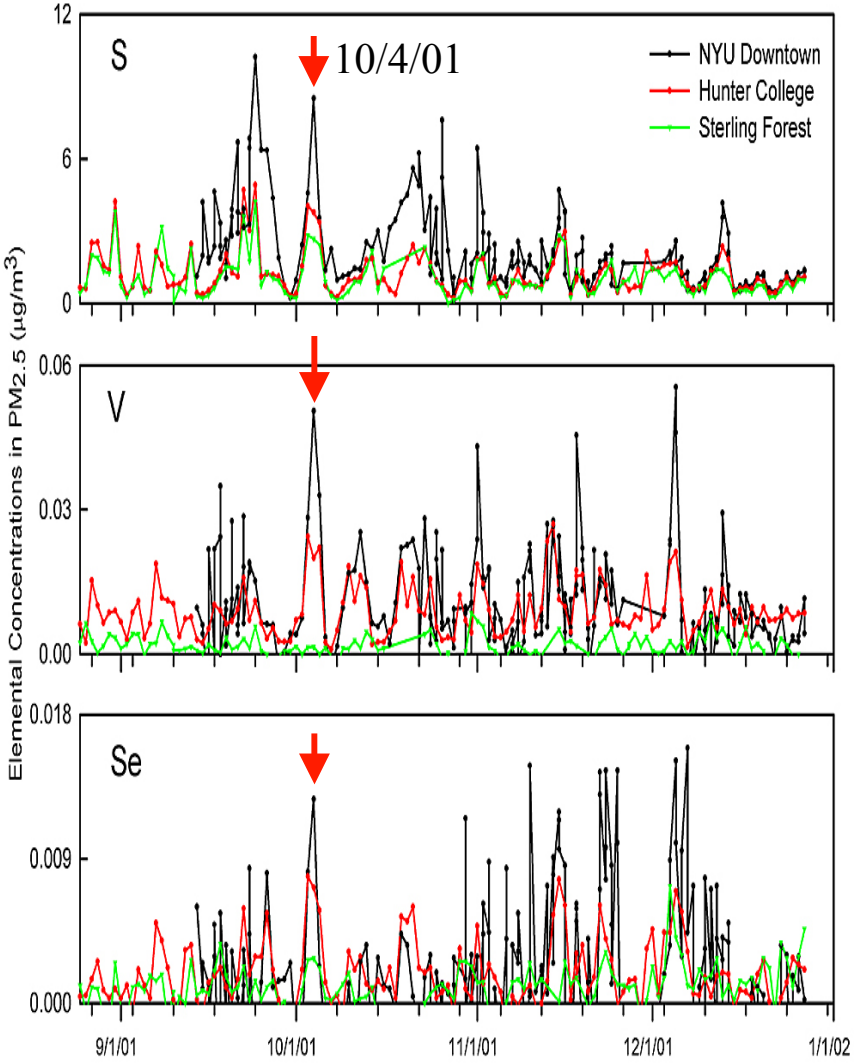
WTC Combustion Particle Tracers at NYU Downtown Indicate Fire Impacts In the Community Largely Ended in Mid-October



WTC Dust Tracers Indicate that Demolition Dust Pollution Increased in Mid-October and Diminished by Mid-November

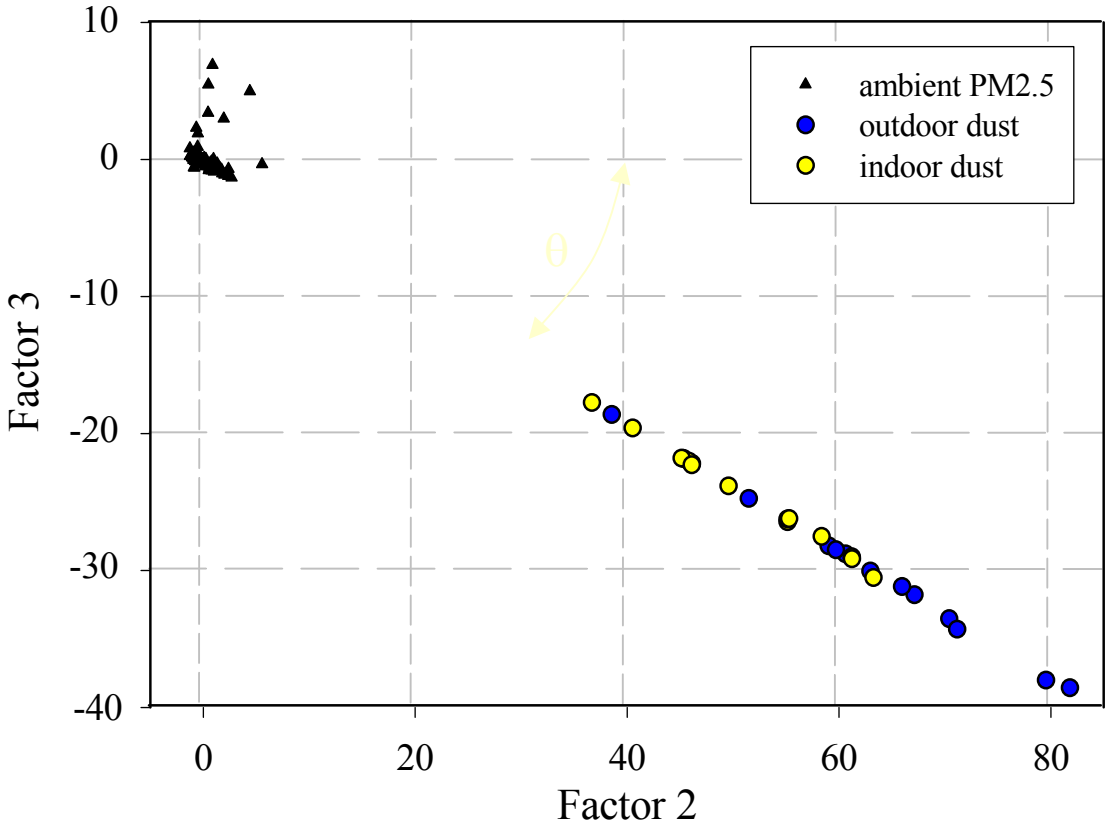


Non-WTC Combustion Particle Tracers Did Not Change their Behavior over the Period



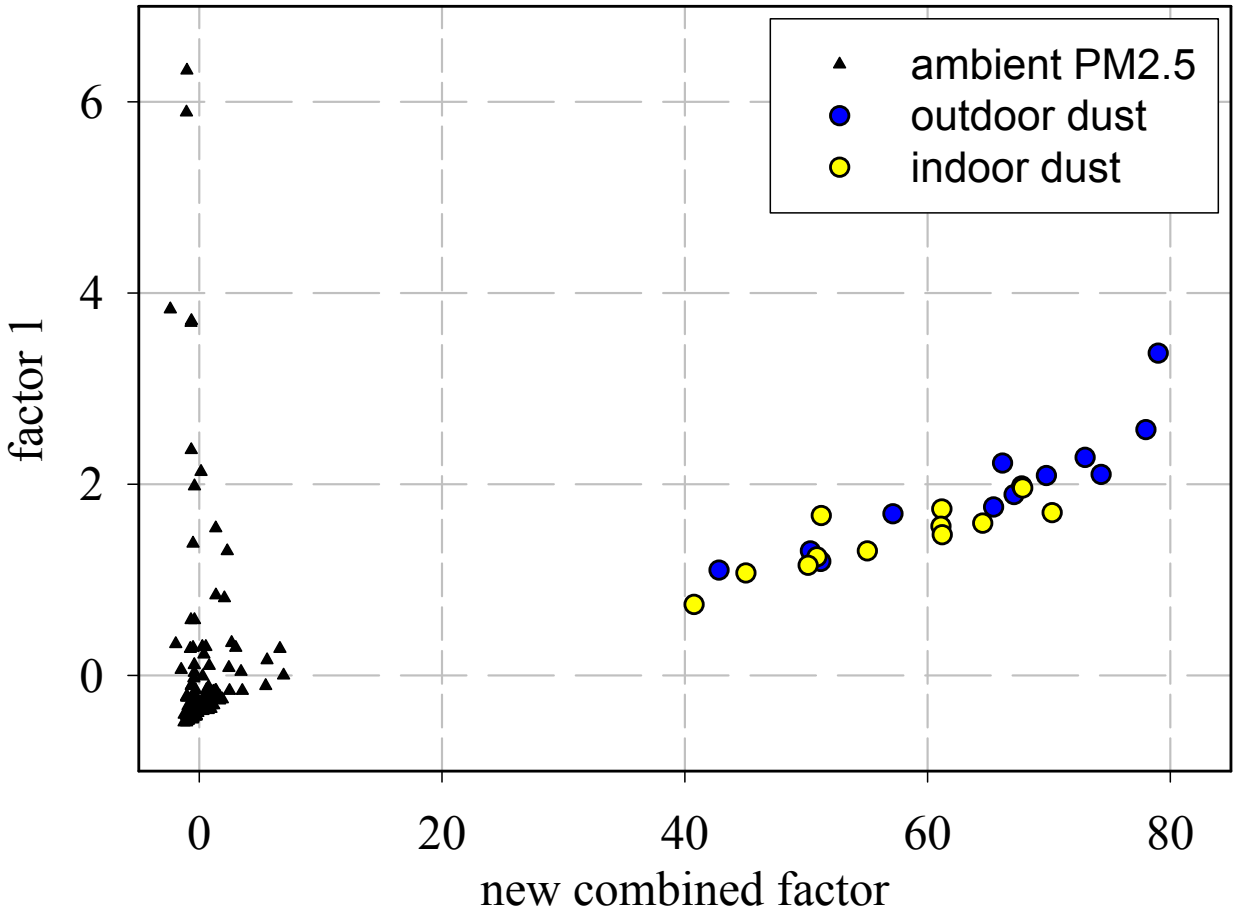
Model to estimate dust contribution to PM2.5 at NYU Downtown Hospital

- Multivariate factor analysis with varimax rotation
  155 ambient PM2.5 samples for 26 elements
  extract 3 factors
- predict 3 scores for
  28 dust samples
  (<2.5 μm fraction)
- find 2 factor scores
  with highest variance



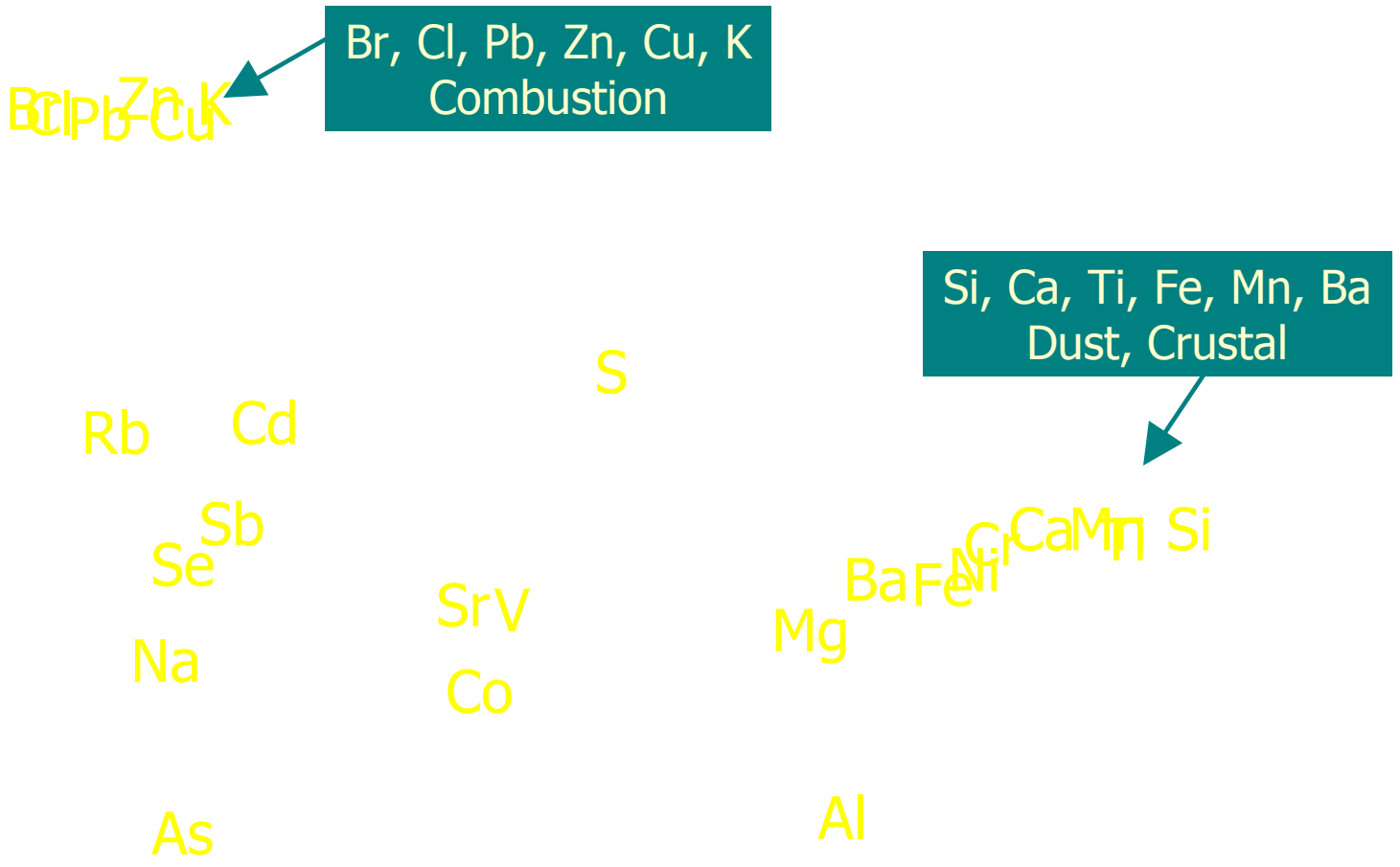
Calculate new combined factor score at NYU Downtown Hospital

- $F_{\text{new combined}} = \cos(\theta)\,\text{Factor2} + \sin(\theta)\,\text{Factor3}$

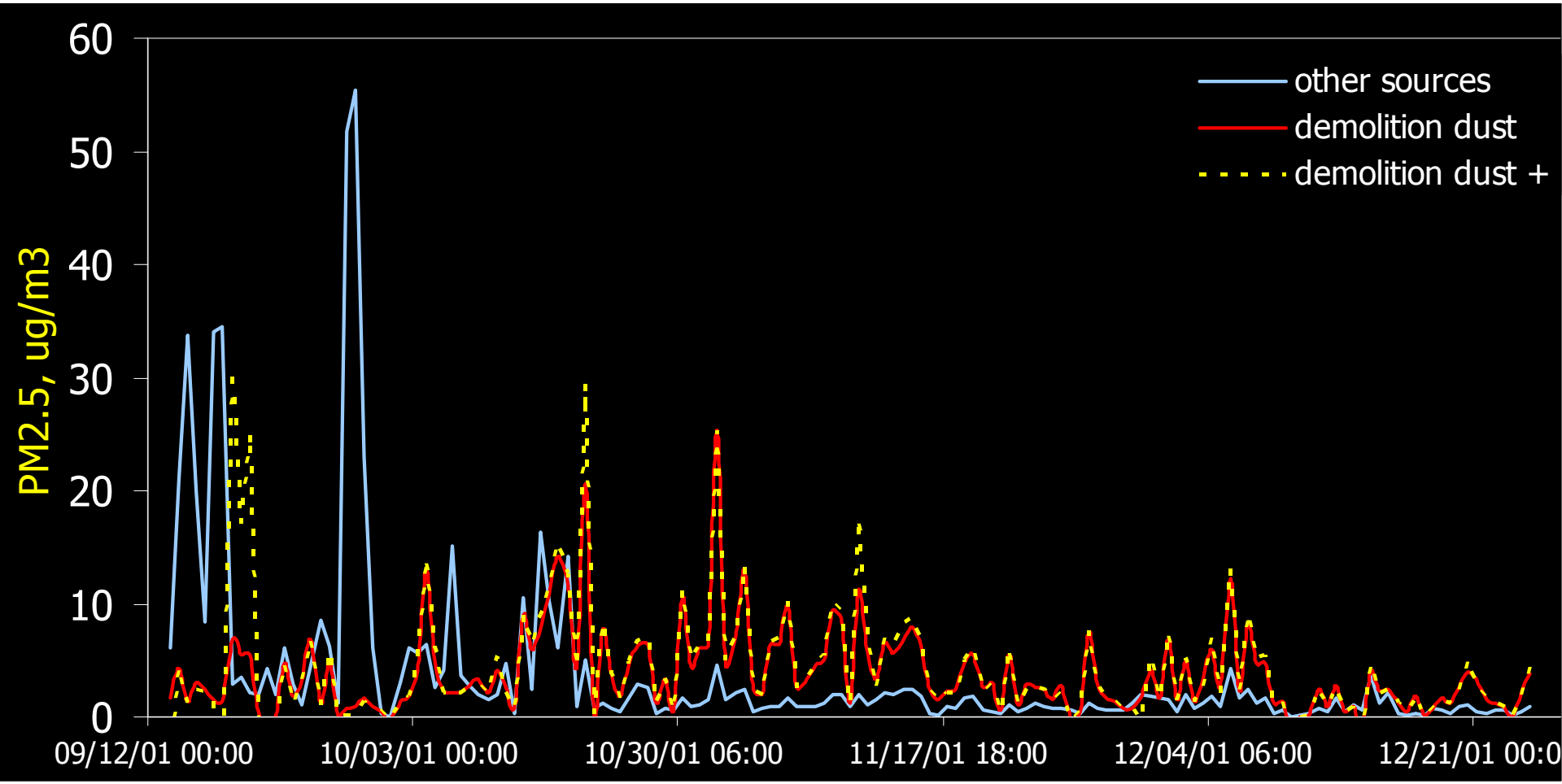


Elements in factor loadings for dust and other source(s) are separated

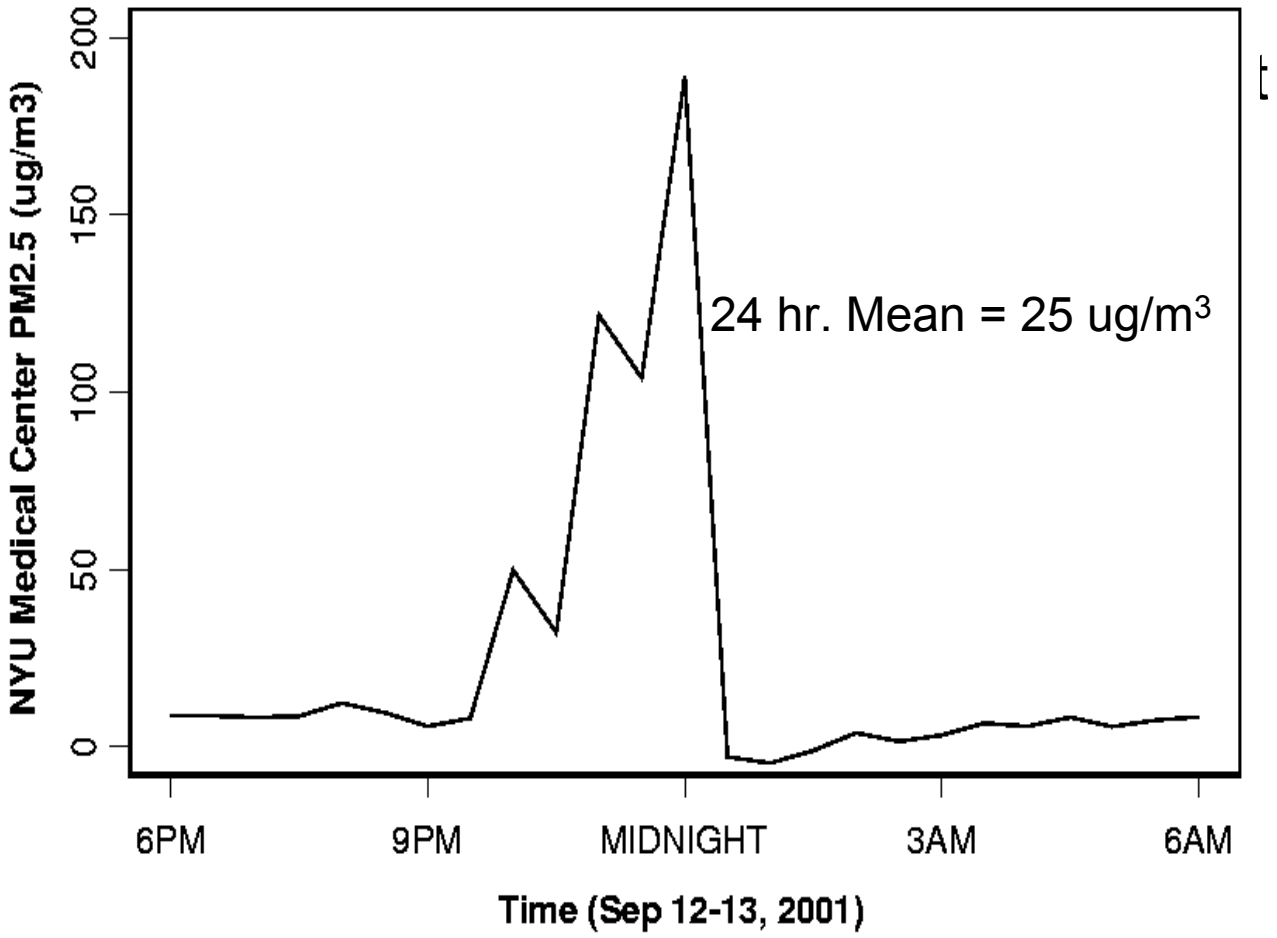
NYU Downtown Hospital



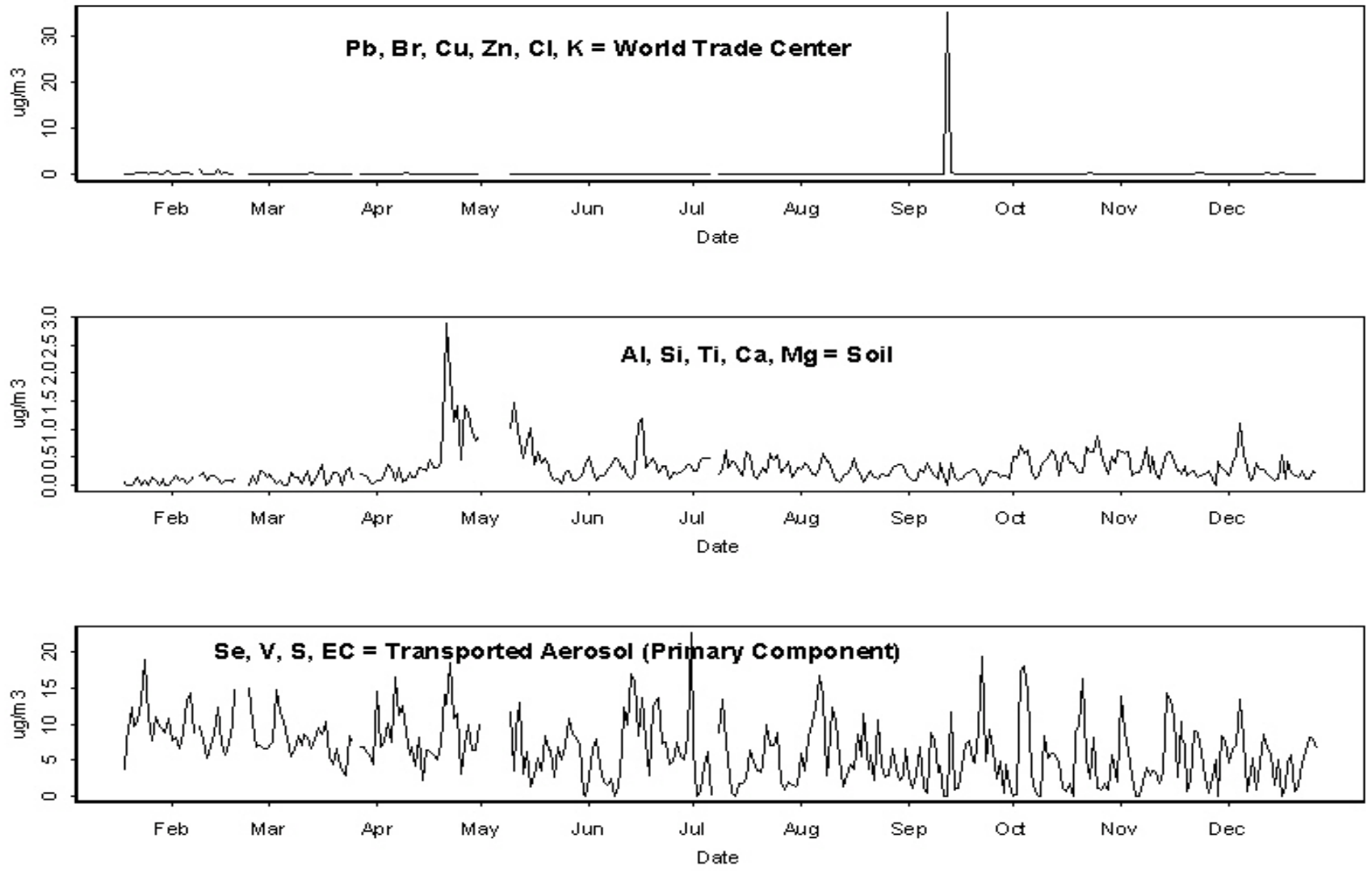
Model predicted mass contributions to ambient PM2.5: Fire Impacts largely ended in mid-October Demolition Dust pollution increased in mid-October and diminished by mid-November (at NYU Downtown Hospital)



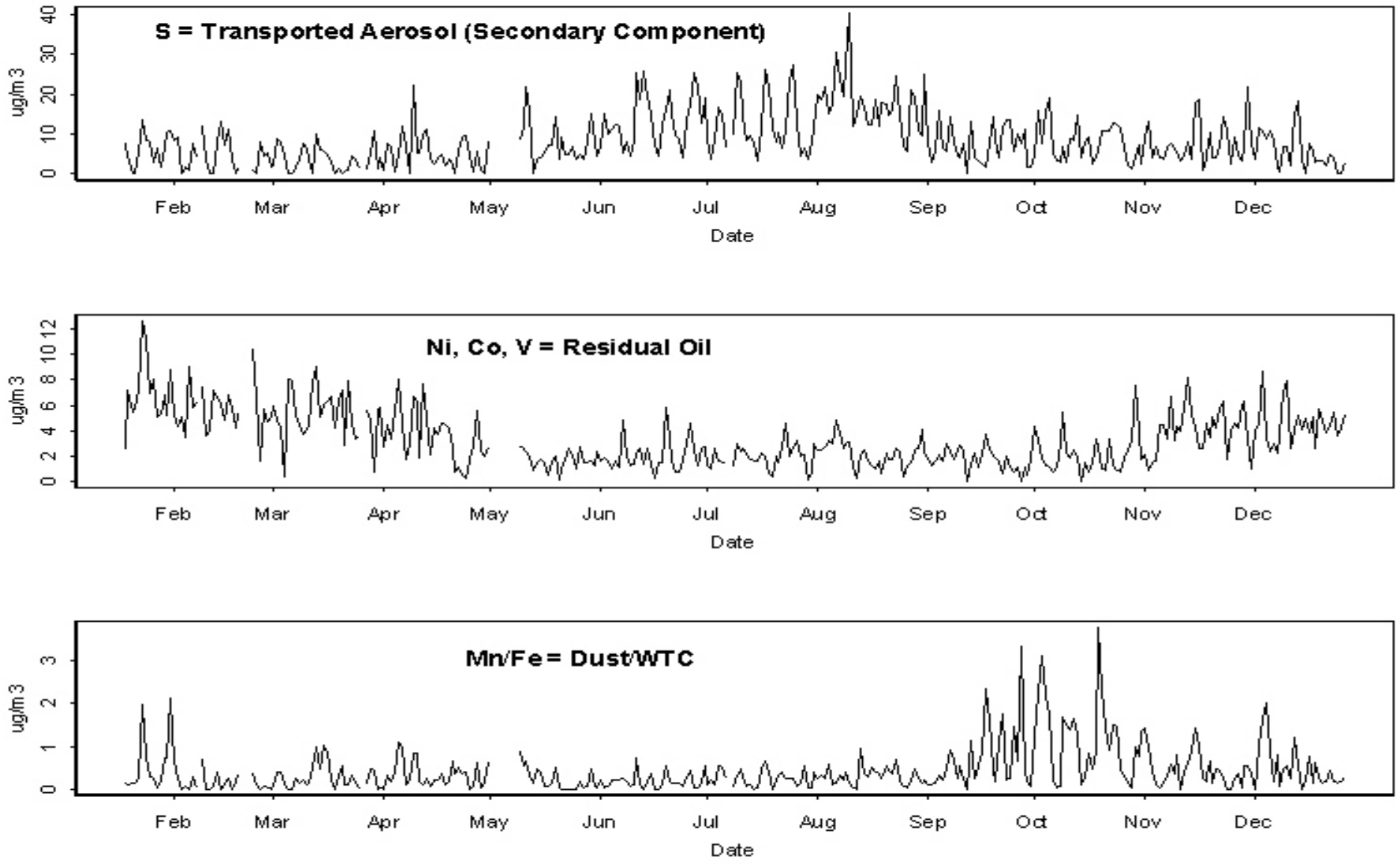
The WTC Plume Clearly "Hit" Our Midtown Site on Sept 12, 2001



Midtown 2001 $PM_{2.5}$ Source Contributions (PMF)



Midtown $PM_{2.5}$ 2001 Source Contributions (PMF)



Summary

- Size-segregated Fallout dust fractions
  - different mass contributions
  - different chemical composition
- Particles >2.5 mm
  - a substantial part of the WTC related dust
  - composed of construction/crustal elements
  - alkalinity of these elements explained "WTC Cough"
- Source Apportionment using PMF or Simple Factor analysis
  - separated the Dust and Other sources elements
  - provided the time series of relative source contributions


Remember